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Original Article

TuCASA questionnaire for assessment of children with obstructive sleep apnea: validation

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ABSTRACT

Objective: The aim of the present study was to validate The Tucson Children's Assessment of Sleep Apnea Study (TuCASA) questionnaire for use in the Brazilian population.
Methods: Of the total 62 children who participated in the present study (27 girls), aged 4 to 11 years, 45 (72.6%) had sleep-disordered breathing (SDB) diagnosed by polysomnography, while 17 (27.4%) had no sleep disorders. Translation, back-translation, and pretesting were previously performed. The final Portuguese-language version of TuCASA was administered to the participants from May 2012 to August 2013. The interviewer was blinded to presence or absence of SDB. Cronbach's alpha for the overall scale (with 95% CI) and the effect of excluding any items were evaluated.
Results: There was no difference among TuCASA items/score and the presence of SDB with either age or gender. The TuCASA had a Cronbach's alpha coefficient of 0.726 (95% CI 0.614 to 0.817), which denotes satisfactory internal consistency – a finding reinforced by evaluation of the effect of item exclusion on the questionnaire. Convergent validity was also satisfactory, in as much as most correlations were positive and significant.
Conclusion: The translated version of the TuCASA questionnaire was validated for Brazilian populations and proved to be a reliable, validated instrument that can be used in clinical practice for evaluation of children with symptoms of SDB.

1. Introduction

The term sleep-disordered breathing (SDB) describes the clinical spectrum of a condition that includes primary snoring, upper airway resistance syndrome (UARS), and obstructive sleep apnea syndrome (OSAS) [1]. The prevalence of OSAS in children is estimated to range between 1% and 3%, with equal distribution between the genders and peak prevalence in preschoolers [2–6].

Unlike adults, children with SDB do not have excessive daytime sleepiness, but rather have symptoms such as: behavioral changes, cognitive dysfunction [3,4], impulsivity [7], impaired balance [8], impaired concentration and learning difficulties, facial growth abnormalities, growth retardation, and hyperactivity [9–13]. Thus, pediatric SDB may lead to major complications such as delayed growth and development, mental retardation, and pulmonary heart disease (cor pulmonale).

The pathophysiology of SDB in childhood is not yet understood, although adenotonsillar hypertrophy, obesity, muscle weakness, and craniofacial dismorphism are factors that may contribute [12–14].

Polysomnography (PSG), the standard for the diagnosis of SDB, is the most accurate method for determining its presence and severity, but is costly and has limited availability [12,15]. In Brazil, the demand for PSG in children far exceeds the number of facilities qualified to perform it, which forces the children and their parents to seek care at major centers, where they are usually placed on a waiting list [13]. The need for expert technicians is a further hindrance to wider access to this diagnostic test.

Questionnaires are very useful tools for the assessment of sleep in children; however, these instruments must be clear, simple, brief, and easy to understand and administer. Several different questionnaires may be used for diagnostic purposes in routine

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clinical practice. Most instruments used for this purpose in Brazil were developed in other countries, and few have been adapted and validated for Portuguese-speaking populations; therefore, it is believed that misinterpretations and certain cultural aspects may influence the specificity and sensitivity of these methods. The need for visual adaptation of instruments should also be taken into account [16]. The use of questionnaires as evaluation parameters is useful, because they can allow standardization, consistency, and reproducibility of the proposed measures. When translating a questionnaire, its measurement properties need to be tested and validated in a pilot group, to enable later use in population studies. Thus, established methods for translation and cross-cultural adaptation allow instruments to be used in a given language and culture.

The Tucson Children's Assessment of Sleep Apnea Study (TuCASA) questionnaire is intended for children aged 4 years to 11 years and comprises 13 items about the symptoms of SBD [12]. This questionnaire has proven to be relevant and reproducible, as demonstrated in several studies [12,17–20], is easy to administer in a clinical setting, and can help determine the symptoms of SDB in Brazilian children. The aim of the present study was to validate a version of the TuCASA questionnaire that had been translated and adapted for use in Brazil [21].

2. Method

2.1. Sample

A total of 62 children (27 girls), aged 4 years to 11 years, participated in the present study; all were chaperoned by their parents and/or guardians. The translation, back-translation, and pretesting, according to the methodology proposed by Guillemin et al. [22] and Beaton et al. [23], was previously performed with the permission of the authors of the original English-language questionnaire [12], yielding a version of the instrument adapted culturally for the Brazilian population (Appendix S1) [21]. Parents and/or guardians signed the Consent Form and the study was approved by the Research Ethics Committee of Universidade Federal de São Paulo, São Paulo-SP, Brazil (No. 1384/10).

2.2. Procedure

The final version of TuCASA, which was culturally adapted for the Brazilian population [21], was administered from May 2012 to August 2013. Of the 62 children evaluated, 45 (72.6%) had SDB diagnosed by PSG, while 17 (27.4%) did not have any sleep disorder. The interviewer was blinded to the presence or absence of SDB.

The TuCASA questionnaire was administered in a single sitting, individually, and by a single investigator at the Neuro-Sono Sleep Center Outpatient department (UNIFESP Department of Neurology). This sleep center serves a heterogeneous population of the city of São Paulo and a large proportion of its patients are of low socioeconomic status. The children's parents or guardians received the questionnaire with instructions and recommendations on how to complete it. No time limit was set for questionnaire completion. Any doubts expressed by respondents were promptly addressed by the investigator who was overseeing data collection.

2.3. Polysomnography

Overnight PSG was performed at the Neuro-Sono Sleep Center; the parents or guardians accompanied the children. A Neuromap® – Neurotec® Version 1.9.7.0 polygraph (Itajubá, MG, Brazil) was used. Each child was monitored with electroencephalography (C3/A2, C4/A1, O1/A2 and O2/A1), left and right eye electro-oculography, and submental surface electromyography. The electrocardiogram was monitored continuously. Arterial oxygen saturation was monitored continuously with a pulse oximeter (Criticare®, Criticare Systems, Inc., Waukesha, WI, USA). Nasal pressure and nasal airflow were measured with a three-way thermistor. Chest and abdominal movements were measured using piezoelectric belts. Leg movements were monitored by electromyography [24].

After test completion, a neurophysiologist blinded to group allocation wrote the PSG report in accordance with the American Academy of Sleep Medicine manual [25].

Respiratory events were counted as per standard criteria for children [24,26]. Obstructive apnea was defined as cessation of airflow for two or more respiratory cycles in the presence of paradoxical breathing and abdominal movements. Hypopnea was defined as a decrease of 50% or greater in thermistor signal amplitude associated with oxyhemoglobin desaturation or arousal [27]. Central apnea was defined as absence of nasal and oral airflow, and chest and abdominal wall movement for 20 s or more, or with concurrent oxyhemoglobin desaturation. The apnea index was defined as the number of apneic events/h of total sleep time, and the apnea–hypopnea index (AHI) as the number of obstructive apnea and hypopnea events/h of total sleep time [26–28]. The AHI was considered to be normal when at least one apneic event occurred/h [24]. Oxyhemoglobin desaturation was defined as a drop of 3% or more in oxygen saturation or a sustained value below 92% [24]. Snoring was defined as wheezing, mostly produced by vibration of the soft palate and faucial pillars, categorized as absent or present, and, if present, classified as mild, moderate or severe.

The criteria were used to score microarousals, defined as lasting 3 s or more and classified into: (1) arousals occurring within 2 s after termination of an apneic event, and (2) arousals not associated with apneic events (spontaneous arousal) [28].

Sleep latency was defined as the time elapsed from lights out until sleep onset, and was categorized as normal (up to 20 min) or increased (more than 20 min) [29]. Sleep efficiency was defined as the ratio of total sleep time to total examination time, and categorized as normal (above 89%) or decreased (below 89%) [29]. Periodic limb movements during sleep (PLMS) were defined as stereotypical limb movements lasting 0.5 s to 5 s and repeating periodically (five or more times every 90 s) [25], and categorized as normal if not exceeding five movements/h of total sleep time.

2.4. Statistical analysis

The Kolmogorov–Smirnov test was used for numeric variables to test normality. Cronbach's alpha [30] for the scale as a whole was evaluated and the effect of the exclusion of each item on the alpha coefficient was assessed, and 95% confidence intervals (95% CI) were considered [31–34]. The questionnaire would be regarded as having acceptable internal consistency if alpha ≥0.6. Because the 13 items of the TuCASA scale are ordinal, the Spearman rank correlation coefficients were used to assess the convergent validity of the questionnaire [35–37]. To assess discriminant validity, the scores of TuCASA of 17 children without SDB were compared with the TuCASA scores of 45 with SBD (diagnosed by PSG). For all analyses, significance was set at $p < 0.05$. All graphs and calculations for the present study were plotted or performed in IBM SPSS Statistics for Windows, Version 20.0 [38].

3. Results

3.1. Analysis of respondents

The validation sample consisted of 35 boys (56.5%) and 27 girls (43.5%), with a mean age of 8.63 ± 1.85 years (Table 1, $p = 0.306$). There was no difference among TuCASA scores and presence of SDB with either gender or age (Table 2).

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Table 1
Distribution of the 62 children who participated in the study, according to gender, age and overall TuCASA score (Z-score).

Age	Gender				Overall	%	*p*-Value
Mean ± SD	Female	%	Male	%	8.53 ± 1.62		0.306
Range	8.41 ± 1.28		8.63 ± 1.85		4–11		
	6–11		4–11				
4 |- 6	0	0.0	3	8.6	3	4.8	
6 |- 8	8	29.7	6	17.1	14	22.6	
8 |- 10	13	48.1	14	40.0	27	43.6	
10|- 12	6	22.2	12	34.3	18	29.0	
Total	27	100.0	35	100.0	62	100.0	
Z-score							
Mean ± SD	38.03 ± 17.0		33.74 ± 14.0		35.61 ± 15.8		0.362
Range	11.5–75.0		13.5–75.0		11.5–15.8		

TuCASA, Tucson Children's Assessment of Sleep Apnea Study.

3.2. Analysis of reliability

The TuCASA scale exhibited a Cronbach's alpha coefficient of 0.726 (95% CI 0.614 to 0.817), which denotes satisfactory internal consistency (Table 3). This was reinforced by evaluation of the effect of the exclusion of each item on the questionnaire.

Table 2
Correlation among gender, age, SDB, TuCASA items, and overall TuCASA score.

	Gender		Age	
	Correlation	*p*-Value	Correlation	*p*-Value
Item 1	0.14	0.910	0.06	0.640
Item 2	0.16	0.212	0.17	0.186
Item 3	0.04	0.780	–0.03	0.834
Item 4	0.10	0.424	0.05	0.720
Item 5	0.19	0.140	–0.11	0.392
Item 6	–0.13	0.293	0.13	0.298
Item 7	0.01	0.947	–0.05	0.718
Item 8	0.06	0.630	0.12	0.348
Item 9	–0.02	0.844	–0.01	0.974
Item 10	–0.01	0.994	0.10	0.424
Item 11	–0.08	0.544	0.04	0.739
Item 12	0.07	0.598	–0.01	0.987
Item 13	0.13	0.293	0.18	0.164
SDB	0.12	0.345	–0.17	0.168
Z-score	0.12	0.362	0.12	0.368

SDB, sleep-disordered breathing; TuCASA, Tucson Children's Assessment of Sleep Apnea Study.

Table 3
Cronbach's alpha coefficients for the TuCASA scale.

Item	Median	Mean ± SD	Alpha if item deleted	Overall scale alpha (95% CI)
Item 1	1.0	1.80 ± 1.09	0.741	0.726 (0.614–0.817)
Item 2	2.0	2.49 ± 1.46	0.699	
Item 3	1.0	1.56 ± 0.92	0.703	
Item 4	1.0	1.31 ± 0.89	0.686	
Item 5	3.0	2.98 ± 1.32	0.718	
Item 6	5.0	4.20 ± 1.22	0.729	
Item 7	2.5	2.39 ± 0.95	0.713	
Item 8	1.0	1.95 ± 1.32	0.688	
Item 9	5.0	3.90 ± 1.49	0.700	
Item 10	1.5	2.36 ± 1.69	0.717	
Item 11	1.0	1.51 ± 0.96	0.709	
Item 12	2.0	2.25 ± 1.47	0.688	
Item 13	2.0	2.95 ± 1.81	0.733	
Z-score	34.6	34.60 ± 15.81		

TuCASA, Tucson Children's Assessment of Sleep Apnea Study.

3.3. Analysis of validity

Of the 34 significant correlations identified between TuCASA items (Table 4), 32 were positive, with values ranging from 0.25 to 0.57. The two negative correlations occurred between item 1 and item 10, and between item 1 and item 11. Significant positive correlations were identified between SDB and seven of the 13 TuCASA items, with values ranging from 0.31 to 0.57.

Considering SDB as the gold standard, and TuCASA items and Z-scores as indicators of the construct the instrument seeks to measure (SDB in children), the scale had satisfactory convergent validity, in as much as the majority of correlations were positive and significant.

On comparison of the scores of each TuCASA item, the 45 children with SDB had higher scores than the 17 children without SDB (Table 5). In accordance with the discriminant validity, such an outcome can be identified in seven of the 13 items of the scale (items 1, 2, 3, 4, 5, 6 and 13), as well as its Z-scores, all with $p < 0.05$, which provides evidence of satisfactory discriminant validity of TuCASA.

4. Discussion

The present study validated an instrument for assessment of symptoms of SDB – the TuCASA questionnaire – in Brazilian children. This instrument proved to be effective for use in research and clinical settings, in that it aids the assessment of SDB symptoms and can thus be used to support the decision to refer children for PSG.

The TuCASA is a clinical evaluation questionnaire that was developed to assess symptoms of SDB in children; it was originally created in English. The instrument was translated and adapted cross-culturally in such a way as to keep semantic, idiomatic, cultural, and conceptual equivalences [21].

In many studies, authors have considered that active participation of the interviewer is necessary and notably importance because of the low level of educational attainment of the Brazilian population. However, for validation of the present version of the TuCASA scale, the proposal of the original questionnaire was followed (ie, a self-report format with minimally active participation from the interviewer) [39].

Content validity assesses whether the items of an instrument contemplate the construct that it is designed to assess and, thus, involves a critical examination of the structure of the instrument and a review of the procedures used to develop it and of its applicability [15,16]. Analysis of the TuCASA questionnaire revealed significant correlations between SDB and seven of its 13 items.

The cornerstones of construct evaluation are convergent and discriminant validity. Convergent validity is supported when different methods of measurement (gold standard) provide similar results

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Table 4
Ordinal correlation between TuCASA items and SDB (convergent validity).

	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Item 12	Item 13	Z-score	SDB
Item 1	1.00	0.25	0.33	0.13	0.42	–0.01	–0.16	0.04	0.12	–0.26	–0.33	0.07	–0.20	0.24	0.51
Item 2		1.00	0.25	0.27	0.48	0.32	0.15	0.47	0.42	0.09	0.04	0.11	–0.04	0.67	0.37
Item 3			1.00	0.46	0.25	0.17	0.25	0.33	0.29	0.20	0.08	0.07	0.15	0.50	0.22
Item 4				1.00	0.39	0.09	0.33	0.40	0.34	0.47	0.39	0.56	0.29	0.60	0.31
Item 5					1.00	–0.10	0.09	0.07	0.22	0.07	0.08	0.16	–0.24	0.41	0.57
Item 6						1.00	0.20	0.30	0.25	–0.17	0.06	0.07	0.11	0.36	0.16
Item 7							1.00	0.33	0.34	0.12	0.37	0.19	0.15	0.45	0.18
Item 8								1.00	0.47	0.12	0.26	0.29	0.29	0.67	0.21
Item 9									1.00	–0.01	0.10	0.18	0.08	0.60	0.35
Item 10										1.00	0.57	0.35	0.19	0.32	–0.14
Item 11											1.00	0.28	0.46	0.48	–0.15
Item 12												1.00	0.13	0.48	0.39
Item 13													1.00	0.42	–0.51
Z-score														1.00	0.32
SDB															1.00

SDB, sleep-disordered breathing; TuCASA, Tucson Children's Assessment of Sleep Apnea Study.

[15,40]. Considering SDB as the gold standard and the TuCASA questionnaire items as indicators of the construct to be measured, the questionnaire showed satisfactory convergent validity, in that most of its correlations were positive and significant. Discriminant validity, in turn, assesses the ability of the instrument to discriminate between different populations (groups with and without the disease) [15,40]. Comparison of the scores of each TuCASA questionnaire item revealed higher scores in the first group (children with SDB) than in the second group (children without any sleep disorder), thus demonstrating discriminant validity.

Reliability is one of the most important properties expected of an instrument. A questionnaire can be considered to be reliable if it consistently produces the same results when applied to the same individuals at different times. Broadly, there are two ways to analyze reliability: by internal consistency and by test–retest reliability [15,41]. Internal consistency is tested by examining the correlation between each item of the instrument (ie, when the items are used to form a scale, they must measure the same construct and must correlate with one another). Cronbach's alpha is a useful measure of internal consistency [15,16]. This coefficient produces a number ranging from 0.0 to 1.0 that represents the extent to which the items of the tested instrument measure the same dimension or construct. The internal consistency of the TuCASA scale was analyzed by evaluating the effect on Cronbach's alpha of deleting each item of the questionnaire. The results of this test provided further evidence of the internal consistency of the TuCASA questionnaire, with a satisfactory and substantial Cronbach's alpha of 0.726.

Table 5
Mean value of each item and overall TuCASA score in people with SDB and people with no sleep disorders (discriminant validity).

	SDB ($n = 45$)	No SDB ($n = 17$)	p-Value
Item 1	2.09 ± 1.14	1.00 ± 0.00	0.000
Item 2	2.71 ± 1.36	1.88 ± 1.54	0.009
Item 3	1.78 ± 1.00	1.00 ± 0.00	0.001
Item 4	1.42 ± 1.01	1.00 ± 0.00	0.049
Item 5	3.33 ± 1.17	2.00 ± 1.22	0.000
Item 6	4.53 ± 0.81	3.35 ± 1.66	0.012
Item 7	2.49 ± 1.01	2.18 ± 0.73	0.223
Item 8	2.11 ± 1.35	1.53 ± 1.18	0.058
Item 9	4.04 ± 1.48	3.35 ± 1.58	0.065
Item 10	2.27 ± 1.67	2.59 ± 1.73	0.427
Item 11	1.47 ± 0.99	1.59 ± 0.87	0.403
Item 12	2.42 ± 1.53	1.71 ± 1.16	0.054
Item 13	2.47 ± 1.79	4.12 ± 1.27	0.001
Z-score	38.67 ± 17.00	27.49 ± 8.00	0.014

SDB, sleep-disordered breathing; TuCASA, Tucson Children's Assessment of Sleep Apnea Study.

5. Conclusion

The version of the TuCASA questionnaire translated into Portuguese and adapted culturally for the Brazilian population was validated and proved to be a reliable, valid instrument that can be used in clinical practice for evaluation of children with symptoms of SDB. It can also be used to increase accuracy when choosing whether to refer children for overnight PSG in a sleep laboratory, which is the standard for diagnosis of SDB.

Conflict of interest

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: http://dx.doi.org/10.1016/j.sleep.2014.09.013.

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Appendix: Supplementary material

Supplementary data to this article can be found online at doi:10.1016/j.sleep.2014.09.013.

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